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Appeal Brief
10/064,451

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BOARD OF PATENT APPEALS AND INTERFERENCES

In re patent application of:
Johnson et al.

Serial No.: 10/064,451

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For: SUSCEPTOR POCKET WITH BEVELED PROJECTION SIDEWALL

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APPELLANTS' APPEAL BRIEF

Sirs:

This Appellants' Appeal Brief is in response to the Notice of Non-Compliant Appeal Brief dated October 30, 2006 setting a one-month period for response, which was in response to the Appellants' Supplemental Appeal Briefs of September 1, 2006 and June 24, 2005. Accordingly, this Appeal Brief is a supplement to the Appellants' Appeal Brief filed March 31, 2005, which was to appeal the final rejection of claims 1-7, 9-15, and 17-18 in the Office Action dated November 30, 2004. This Appeal Brief is therefore timely filed.

I. REAL PARTY IN INTEREST

The real party in interest is International Business Machines Corp., Armonk, New York, assignee of 100% interest of the above-referenced patent application.

II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to Appellants, Appellants' legal representative or Assignee which would directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

III. STATUS OF CLAIMS

Claims 1-7, 9-15, and 17-18 are all the claims pending in the application and are set forth fully in the attached appendix. Claims 1-18 were originally filed in the application. Appellants filed an Amendent under 37 C.F.R. §1.111 on April 8, 2004 amending the claims. Appellants filed an Amendent under 37 C.F.R. §1.111 on May 27, 2004 further amending the claims. Appellants filed an Amendent under 37 C.F.R. §1.116 on July 28, 2004 further amending the claims and cancelling claims 8, and 16. Appellants filed an Amendent under 37 C.F.R. §1.111 on October 22, 2004 further amending the claims and cancelling claims 8, and 16 and adding claim 19. Appellants filed an Amendent under 37 C.F.R. §1.116 on January 31, 2005 cancelling claim 19. An Advisroy Action was issued on February 18, 2005 indicating that the Amendment filed on January 31, 2005 would be entered for purposes of Appeal, but that the rejections to the claims would be sustained. A Notice of Appeal was filed on February 24, 2005, and an Appeal Brief was timely filed on March 31, 2005, which was to appeal the final rejection of claims 1-7, 9-15, and 17-18 in the Office Action dated November 30, 2004. A non-final Office Action was

issued May 25, 2005 to reopen prosecution in the application. Appellants' have requested reinstatement of the Appeal, with the claims shown in the appendix are shown in their amended form as of the January 31, 2005 Amendment.

Claims 1-7, 9-15, and 17-19 stand rejected under 35 U.S.C. §112, first paragraph. Claims 1-7, 9-15 and 17-18 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Honma, et al. (U.S. Patent No. 6,596,086), hereinafter referred to as "Honma", in view of Hoshina, et al. (U.S. Patent No. 5,785,764), hereinafter referred to as "Hoshina". Claims 1-7, 9-15 and 17-18 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Zhao, et al. (U.S. Patent No. 5,968,379), hereinafter referred to as "Zhao", in view of Hoshina.

IV. STATEMENT OF AMENDMENTS

An after-final Office Action dated November 30, 2004 stated that claims 1-7, 9-15, and 17-19 were rejected. Appellants filed an Amendent under 37 C.F.R. §1.116 on January 31, 2005 cancelling claim 19. An Advisory Action was issued on February 18, 2005 entering the January 31, 2005 Amendment for purposes of appeal. The claims shown in the appendix are shown in their amended form as of the January 31, 2005 amendment.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The Appellants' claimed invention is described in pages 3-6 (paragraphs [0011] through [0024]) of the specification and shown in Figures 1 through 3 of the application as originally filed. Please note that the lines numbers indicated below reflect the line numbers corresponding to the lines in the respective paragraph numbers in the specification. The Appellants are including herewith a copy of the specification, claims, abstract, and drawings as originally filed

in accordance with the suggestion by the Examiner during a telephone conference between the Examiner and the undersigned attorney on November 6, 2006. More specifically, with respect to the claimed subject matter:

Claim 1: An apparatus 100 for holding a substrate 120 (lines 1-2 of paragraph [0018] (page 4) of the specification and FIG. 1), wherein the apparatus 120 comprises a pocket 125 adapted to hold the substrate 120 (lines 3-5 of paragraph [0018] (page 4) of the specification and FIG. 1), wherein the pocket 125 comprises an inner edge 110 (lines 3-5 of paragraph [0018] (page 4) of the specification and a lower surface (shown as an unnumbered structure in FIG. 2; the lower surface of the pocket 125 constitutes the surface where the substrate 120 rests on); a plurality of projections 115 extending radially inward from the inner edge 110 (lines 5-6 of paragraph [0018] (page 4) of the specification); an opening 210 in the lower surface (lines 3-4 of paragraph [0020] (page 5) of the specification and FIG. 2); and a pin 215 disposed in the opening 210 (lines 3-4 of paragraph [0020] (page 5) of the specification and FIG. 2), the pin 215 being configured for lifting the substrate 120 from the pocket 125 (lines 3-4 of paragraph [0020] (page 5) of the specification and FIG. 2); wherein the projections 115 have a beveled edge (line 1 of paragraph [0021] (page 5) through line 7 of paragraph [0022] (page 6) of the specification and FIGS. 2-3), such that an acute angle 201 greater than 80 degrees occurs between the lower surface and the beveled edge (lines 1-8 of paragraph [0021] (pages 5-6) of the specification and FIG. 3), and wherein the projections 115 reduce an area of contact between the inner edge 110 and the substrate 120 (lines 1-11 of paragraph [0020] (pages 5-6) of the specification).

Claim 2: The apparatus 100 comprises a susceptor for holding the substrate 120 (lines 1-

2 of paragraph [0018] (page 4) of the specification).

Claim 3:. The projections 115 have a "C" shape (lines 8-10 of paragraph [0018] (page 4) of the specification and FIG. 1).

Claim 4: The projections 115 maintain a gap between a sidewall of the substrate 120 and the inner edge 110 (lines 4-6 of paragraph [0020] (page 5) of the specification and FIGS. 2 and 3).

Claim 5: The acute angle 201 comprises an angle not greater than 85 degrees (lines 5-8 of paragraph [0021] (pages 5-6) of the specification).

Claim 6: The projections 115 prevent the substrate 120 from moving within the pocket 125 (line 7 of paragraph [0022] (page 6) of the specification).

Claim 7: An apparatus 100 for holding a substrate 120 (lines 1-2 of paragraph [0018] (page 4) of the specification and FIG. 1), the apparatus 100 comprising a pocket 125 adapted to hold the substrate 120 (lines 3-5 of paragraph [0018] (page 4) of the specification and FIG. 1), wherein the pocket 125 comprises an inner edge 110 (lines 3-5 of paragraph [0018] (page 4) of the specification and a lower surface (shown as an unnumbered structure in FIG. 2; the lower surface of the pocket 125 constitutes the surface where the substrate 120 rests on); a plurality of projections 115 extending radially inward from the inner edge 110 (lines 5-6 of paragraph [0018] (page 4) of the specification); and an opening 210 in the lower surface (lines 3-4 of paragraph

[0020] (page 5) of the specification and FIG. 2); wherein the projections 115 have a beveled edge (line 1 of paragraph [0021] (page 5) through line 7 of paragraph [0022] (page 6) of the specification and FIGS. 2-3), and wherein an acute angle 201 greater than 80 degrees occurs between the lower surface and the beveled edge (lines 1-8 of paragraph [0021] (pages 5-6) of the specification and FIG. 3).

Claim 9: The projections 115 reduce an area of contact between the inner edge 110 and the substrate 120 (line 1 of paragraph [0020] (page 5) through line 11 of paragraph [0021] (page 6) of the specification).

Claim 10: The apparatus comprises a susceptor for holding the substrate 120 (lines 1-2 of paragraph [0018] (page 4) of the specification).

Claim 11: The projections 115 have a "C" shape (lines 8-10 of paragraph [0018] (page 4) of the specification and FIG. 1).

Claim 12: The projections 115 maintain a gap between a sidewall of the substrate 120 and the inner edge 110 (lines 4-6 of paragraph [0020] (page 5) of the specification and FIGS. 2 and 3).

Claim 13: The acute angle 201 comprises an angle not greater than 85 degrees (lines 5-8 of paragraph [0021] (pages 5-6) of the specification).

Claim 14: The projections 115 prevent the substrate 120 from moving within the pocket 125 (line 7 of paragraph [0022] (page 6) of the specification).

Claim 15: A susceptor 100 for holding a wafer 120 (lines 1-2 of paragraph [0018] (page 4) of the specification and FIG. 1), the susceptor 100 comprising a pocket 125 adapted to hold the wafer 120 (lines 3-5 of paragraph [0018] (page 4) of the specification and FIG. 1), wherein the pocket 125 comprises an inner edge 110 (lines 3-5 of paragraph [0018] (page 4) of the specification and a lower surface (shown as an unnumbered structure in FIG. 2; the lower surface of the pocket 125 constitutes the surface where the substrate 120 rests on); a plurality of projections 115 extending radially inward from the inner edge 110 (lines 5-6 of paragraph [0018] (page 4) of the specification); and a device 215 positioned below the pocket 125 (lines 3-4 of paragraph [0020] (page 5) of the specification and FIG. 2), the device 215 being configured for lifting the wafer 120 from the pocket 125 (lines 3-4 of paragraph [0020] (page 5) of the specification and FIG. 2); wherein the projections 115 have a beveled edge (line 1 of paragraph [0021] (page 5) through line 7 of paragraph [0022] (page 6) of the specification and FIGS. 2-3), and wherein an acute angle 201 greater than 80 degrees occurs between the lower surface and the beveled edge (lines 1-8 of paragraph [0021] (pages 5-6) of the specification and FIG. 3).

Claim 17: The acute angle 201 is not greater than 85 degrees (lines 5-8 of paragraph [0021] (pages 5-6) of the specification).

Claim 18: The projections 115 have a "C" shape (lines 8-10 of paragraph [0018] (page 4) of the specification and FIG. 1).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The issues presented for review by the Board of Patents Appeals and Interferences are whether claims 1-7, 9-15, and 17-18 fail to comply with the written description requirement under 35 U.S.C. §112, first paragraph, and whether claims 1-7, 9-15, and 17-18 are unpatentable under 35 U.S.C. §103(a) as being unpatentable over Honma in view of Hoshina, and whether claims 1-7, 9-15 and 17-18, are unpatentable under 35 U.S.C. §103(a) as being unpatentable over Zhao in view of Hoshina.

Claims 1-7, 9-15, and 17-19 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. According to the Office Action of May 25, 2005, the claims contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention.

Claims 1-7, 9-15 and 17-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Honma in view of Hoshina. According to the Office Action, Honma discloses a susceptor having a pocket to hold substrate having an inner edge and a lower surface (Fig. 1, element 5a) and opening in lower surface for lift pins to lift the substrate (element 5b). The Office Action admits that Honma does not disclose plurality of beveled edge projections extending radially inward from the inner edge. However, the Office Action suggests that Hoshina discloses a susceptor with a pocket to hold a substrate, and a plurality of C shaped projections (Fig. 5A, element 17) extending radially inwards at an acute angle of 80 degrees (complementary 10 degrees) with respect to bottom of pocket (Col. 3 lines 10-43 and Col. 7 lines 5-15). Inherently, according to the Office Action, these projections maintain a gap below the projection and restrict

the movement of the standard substrate with a straight edge.

The Office Action concludes that it would have been obvious for one of ordinary skill in the art at the time of invention to have a plurality of projection in order to hold substrate in position with a very small area of contact. Regarding the limitation of the angle being even slightly greater than 80 degrees, the Office Action states that "it should be understood that slight variability of angle would be obvious in view of experimental optimization and difficulty of maintaining close tolerance."

Claims 1-7, 9-15 and 17-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao in view of Hoshina. According to the Office Action, Zhao discloses a susceptor having a pocket to hold substrate having an inner edge and a lower surface (Fig. 2, element 34) and opening in lower surface for lift pins to lift the substrate (Col. 11 line 1-18 and Col. 19 lines 1-8). The Office Action admits that Zhao does not disclose plurality of beveled edge projections extending radially inward from the inner edge. However, the Office Action suggests that Hoshina discloses a susceptor with a pocket to hold a substrate, and a plurality of C shaped projections (Fig. 5A, element 17) extending radially inwards at an acute angle of 80 degrees (complementary 10 degrees) with respect to bottom of pocket (Col. 3 lines 10-43 and Col. 7 lines 5-15). Inherently, according to the Office Action, these projections maintain a gap below the projection and restrict the movement of the standard substrate with a straight edge. The Office Action concludes that it would have been obvious for one of ordinary skill in the art at the time of invention to have a plurality of projection in order to hold substrate in position with a very small area of contact.

VII. ARGUMENT

A. The Rejections Based on 35 U.S.C. §112, First Paragraph

The Office Action states that "[t]he specification does not discuss the acute angle to be greater than 80 degrees." However, paragraph [0021] of the specification, as originally filed, clearly states:

> Figure 2 also illustrates angles 200, 201 that [are] formed by the beveled side wall of the projection 115. The region 205 is shown in magnified form in Figure 3. The angle 200 is generally between 5 and 10 degrees, although the invention is not limited to this specific range of angles, but is applicable to all ranges of appropriate angles, depending upon the specific application being addressed. Therefore, the angle 201 comprises an acute angle. Thus, the angle between the bottom of the pocket 125 and the linear inclined surface of the projection 115 is less than 90 degrees (e.g., 80-85 degrees).

Contrary to the erroneous conclusion reached in the Office Action, there is clear disclosure in the specification, as originally filed, of an angle greater than 80 degrees. Clearly, there appears to be a misunderstanding of basic mathematical principles. Basic mathematical rules provide that the phrase "greater than" means non inclusive of the lower numerical range. In the Appellants' case, "greater than" means greater (but not equal) to 80 degrees. Similarly, an acute angle not greater than 85 degrees means less than or equal to 85 degrees according to basic mathematical concepts. Apparently, the position taken in the Office Action, for which the rejection is being based upon, is contrary to the Appellants' interpretation of basic mathematical concepts.

The Office Action indicates that no disclosure and appreciation of any unexpected advantage of an angle greater than 80 but not exactly 80 is required (see page 3 of Office Action of May 25, 2005). However, no such requirement is dictated by 35 U.S.C. §112, first paragraph. Thus, Appellants' specification does provide those of ordinary skill in the art with a sufficient written description in order to practice Appellants' invention without undue experimentation.

Therefore, Appellants strongly contend that the position taken in the Office Action is erroneous, and that claims 1-7, 9-15, and 17-19 absolutely comply with the written description requirement of 35 U.S.C. §112, first paragraph, and that the claims contain subject matter which was described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Therefore, the Board is respectfully requested to reconsider and withdraw the rejections to claims 1-7, 9-15, and 17-19.

B. The Prior Art Rejections Based on 35 U.S.C. §103(a) - The Prior Art

1. The Honma Reference

Honma teaches in an apparatus for vapor phase growth of silicon single crystal thin films, in-plane uniformity of susceptor temperature is improved and film thickness of a silicon single crystal thin film is uniformized. The base material of a lift pin 8 provided in a pocket 5a of a susceptor 5 is changed to a base material lower in thermal conductivity than a base material of the susceptor 5, by which local decreases in susceptor temperature in the vicinity of the lift pin are prevented. As the base material of the lift pin 8, SiC, carbon of a desired grade and quartz are preferred.

2. The Hoshina Reference

Hoshina teaches a susceptor 1 for a gas phase growth apparatus to which a round depressed pocket 2 with a bottom a side wall is formed for the placing of a semiconductor wafer 3 wherein a protuberance 6 is provided on the circumference of the pocket at and near the position where the semiconductor wafer touches the side wall 4 of the pocket 2 in such a way

that the protuberance 6 covers a part of a chamfered area of the semiconductor wafer 3 without touching it. Thus, cracks and breakage due to adhesion between a susceptor and a wafer may be prevented.

3. The Zhao Reference

Zhao teaches systems, methods, and an apparatus for depositing titanium films at rates up to 200 Å/minute on semiconductor substrates from a titanium tetrachloride source. A ceramic heater assembly with an integrated RF plane for bottom powered RF capability allows PECVD deposition at a temperature of at least 400°C for more efficient plasma treatment. A thermal choke isolates the heater from its support shaft, reducing the thermal gradient across the heater to reduce the risk of breakage and improving temperature uniformity of the heater. A deposition system incorporates a flow restrictor ring and other features that allow a 15 liters/minute flow rate through the chamber with minimal backside deposition and minimized deposition on the bottom of the chamber, thereby reducing the frequency of chamber cleanings, and reducing clean time and seasoning. Zhao also teaches deposition and cleaning processes.

C. Appellants' Position

1. Independent Claims 1, 7, and 15

(a) The Rejection Based on Honma in view of Hoshina

Appellants respectfully traverse the rejections in the Office Action of independent claims 1, 7, and 15 based on the following discussion. Regarding independent claims 1, 7, and 15, first, the references, separately, or in combination, fail to disclose, teach or suggest a reason or motivation for being combined. Second, even assuming that the references would have been legally combinable, Honma does not teach or suggest the features of independent claim 1, and

similarly independent claims 7 and 15, including the projections have a beveled edge, such that an acute angle greater than 80 degrees occurs between the lower surface and the beveled edge.

Indeed, the Office Action admits that Honma "do[es] not disclose [a] plurality of beveled edge projections extending radially inward from the inner edge," and thus, Honma is deficient in failing to disclose the above feature of Appellants' claimed invention. (See Office Action, Page 2, Section 2). Hoshina is also deficient.

In contrast, Figures 1A, 1B, 2, and 5A of Hoshina merely disclose a susceptor 1 for a gas phase growth apparatus to which a round depressed pocket 2 with a bottom a side wall is formed for the placing of a semiconductor wafer 3 where a protuberance 6 is provided on the circumference of the pocket at and near the position where the semiconductor wafer touches the side wall 4 of the pocket 2 and a back side of the wafer touches the bottom 5 of the pocket 2 so that an angle θ_1 is formed between a side 6a of the protuberance facing the bottom 5 of the pocket 2 and the bottom 5 of the pocket is set to be an acute angle." Contrary to the assertion in the Office Action, the acute angle in Hoshina is in a "range of 40-80 degrees, preferably in a range of 60-75 degrees," and is not greater than 80 degrees between a lower surface and a beveled edge as claimed by Appellants. (See Hoshina at Abstract; Column 3, lines 10-43; Column 5, lines 1-13; Column 7, lines 5-15; and Figures 1A, 1B, 2 and 5A).

To reiterate, page 2 of the Office Action states that "Hoshina et al disclose a susceptor with a pocket to hold a substrate, [and a] plurality of C shaped projections (Fig 5A-17) extending radially inward[s] at an acute angle of 80 degrees (complementary 10 degrees) with respect to [the] bottom of [the] pocket." Appellants completely agree with this fact. However, this is not what the Appellants' claimed language is directed to. Clearly, the Appellants' claimed language is contrary to this. Again, independent claim 1 states, in part, "...wherein said projections have a

beveled edge, such that an acute angle greater than 80 degrees occurs between said lower surface and said beveled edge...." Independent claims 7 and 15 state, in part, "...wherein an acute angle greater than 80 degrees occurs between said lower surface and said beveled edge." Clearly, there appears to be a misunderstanding of basic mathematical principles. Appellants contend that a "range of 40-80 degrees" provided in Hoshina does not overlap the claimed "greater than 80 degrees." Basic mathematical rules provide that the phrase "greater than" means non inclusive of the lower numerical range. In the Appellants' case, "greater than" means greater (but not equal) to 80 degrees. In Hoshina, the "range of 40-80 degrees" means at most 80 degrees for the upper bound of the range. Apparently, the position taken in the Office Action, for which the rejection is being based upon, is contrary to the Appellants' interpretation of basic mathematical concepts. Therefore, Appellants strongly contend that Hoshina cannot and does not teach the claimed invention even if combined with Honma.

Page 4 of the Office Action states that, "[S]ince Hoshina discloses [an] angle of 80 degrees, it is in [the] overlapping range with the claim of 80-85 degrees." First, none the Appellants' claims recite a range of 80-85 degrees. Second, for the reasons stated above, the Appellants' claims are directed at a range of greater than 80 degrees (independent claims 1, 7, and 15) and not greater than 85 degrees (dependent claims 5, 13, and 17). Thus, the position in the Office Action is clearly erroneous as the claimed invention is not in the overlapping range cited in Hoshina.

In other words, Hoshina teaches away from Appellants' claimed invention. As indicated, if the "angle θ_1 is larger than 80 degrees, then, when forming a thick thin film, the amount of the source material gas which flows around to the contact area between the wafer 3 and the side wall 4 of the pocket 2 and its vicinity increases and cross bridges grow due to the deposition of

silicon, resulting in adhesion which causes cracks or breakage when taking out the wafer 3 from the pocket 2 after the gas phase growth."

Accordingly, Hoshina's invention cannot operate effectively when the angle θ_1 is larger than 80 degrees and improve film uniformity without errors. Contrary to this, Appellants' invention is indeed workable without errors when the angle is greater than 80 degrees. Therefore, Appellants' invention is not obvious, and one of ordinary skill in the art would not attempt to increase the angle θ_1 to be larger than 80 degrees as suggested in the Office Action because Hoshina, as indicated above, suggests his invention would be unworkable if an angle of greater than 80 degrees was used. Thus Hoshina does not teach or suggest including the features "the projections have a beveled edge, such that an acute angle greater than 80 degrees occurs between the lower surface and the beveled edge." (See Column 5, lines 20-32 of Hoshina).

Appellants teach an apparatus for holding a substrate including projections having a beveled edge of a projection 115 where an acute angle 201 greater than 80 degrees occurs between the lower surface of an opening and the beveled edge. Since angle 200 combined with the complimentary acute angle 201 forms a 90 degree angle and, as indicated, "angle 200 is generally between 5 and 10 degrees," then angle 201 includes an acute angle less than 90 degrees, "e.g., 80-85 degrees." As a result, the acute angle 201 is greater than 80 degrees between the lower surface and the beveled edge.

The criticality of the Appellants' acute angle 201 being greater than 80 degrees is that the beveled side of wall of the projection reduces the contact area between the projection 115 and the substrate 102, thereby reducing the possibility that the substrate 120 will stick within the pocket of the apparatus 100. Accordingly, the Appellants' invention improves film uniformity of the semiconductor wafer undergoing processing while providing small points of contact with the

wafer, and thus improving the angle of the contacts to prevent errors. (See Paragraph [0023] of Appellants' specification).

As previously indicated, the angle configuration (greater than 80 degrees) is quite critical to the Appellants' claimed invention, and is not merely a design choice. The Appellants' claimed invention provides an apparatus/susceptor which is utilized in wafer processing, and in particular in heavy volume wafer processing. As such, manufacturing speed and efficiency are central to use of the Appellants' claimed invention in heavy volume wafer processing. Thus, the lifting pin provided by the Appellants' claimed invention aids in speeding the wafer processing as opposed to manual lifting or lifting by an unattached and/or incongruous mechanism. However, the device in Hoshina does not provide lifting pins, and as such is suggestive of not being incorporated in heavy wafer processing, and while the device in Honma appears to teach lift pins, suggesting use in heavy wafer processing, it would not be logical or obvious to combine Honma with Hoshina because each is directed to a different type of wafer processing scheme (i.e., heavy volume wafer processing vs. non-heavy volume wafer processing). Nonetheless, even if Honma were to be legally combined with Hoshina, they would still fail to teach all of the elements of the claimed invention, particularly that the angle configuration between the lower surface of the pocket and the beveled edge of the projection being greater than 80 degrees.

In non-heavy volume wafer processing, such as Hoshina, the susceptor may be positioned sufficiently level such that it does not move (i.e., through vibrations, etc.). However, in most conventional heavy volume wafer processing susceptors, due to the speed at which these devices operate, vibrational forces tend to shift the susceptor causing it to become non-leveled, which may cause the wafer to slide slightly on one side of the susceptor, which then causes the wafer to be in contact with two beveled retainers. In this case, the angle of the retainers is extremely

critical. If the angle is less than 80 degrees, as demonstrated during the loading/unloading tests (when the wafer being lifted from the pocket), scratches result on the edge of the wafer due to excessive contact/friction between wafer and retainers. This creates foreign material generation and can result in wafer failure (i.e., wafer breakage). The Office Action, on page 4, states that "[t]here is no mention of the amount of scratches when the angle is exactly 80 degrees." However, it is irrelevant what the results are at exactly 80 degrees because the claimed language is not directed to exactly 80 degrees, but rather greater than 80 degrees. Therefore, the retainer angle is very critical and must be greater than 80 degrees for the device to function properly. In fact, experimental testing performed on the apparatus/susceptor provided by the Appellants' invention illustrated that all wafer transfers (loading/unloading testing) were friction free (i.e., no scratches or breakage) at angles greater than 80 degrees.

Hoshina clearly states, in col. 3, lines 23-28, col. 5, lines 6-12, and col. 7, lines 10-15 that the angle is in the range of 40-80 degrees, and preferably in the range of 60-75 degrees. However, such a range of angles would be unworkable for the claimed invention to function properly. This is so because using any angle less than 80 degrees would result in severe wafer errors (such as WOOPS errors as described on paragraph [0004] of the Appellants' specification. In fact, empirical data gathered by the Applicants further illustrates this, wherein the data was gathered based on visual inspections of wafer edges after loading and unloading of wafers in a susceptor (as would be used in heavy volume wafer processing). In order to test the results achieved by prior art devices, different angle configurations were tested including angles of 45 and 60 degrees. For 45 degree angles, out of 50 instances of loading/unloading of wafers in a susceptor, the results showed two broken wafers and 33 wafers with edge marks (scratches). At 60 degrees, the results showed one broken wafer and 24 wafers with edge marks (scratches).

Furthermore, page 5 of the Office Action states that "[t]he specification does not indicate that an angle even slightly greater than 80 has any critical importance." However, case law and the MPEP clearly do not require that the specification specifically state that dimensional limitations are critical (see MPEP §716.02(f)). Thus, it is irrelevant whether the specification does or does not discuss the criticality of the dimensions.

In fact, the criticality of the angle provided by the claimed invention would not obvious to one of ordinary skill in the art, who may be a technician overseeing the wafer processing, given that the prior art, namely Hoshina, provides a preferable range of an angel between 60 and 75 degrees. Thus, one of ordinary skill in the art would have clearly read Hoshina to provide the preferable parameters of a susceptor device, and without undue experimentation, would have used these preferable parameters in constructing a similar device. However, the Appellants determined that using conventional devices still resulted in wafer errors (i.e., WOOPS errors), and determined that the angle between the lower surface of the pocket and the beveled edge of the projection was in fact critical and that this angle had to be greater than 80 degrees to overcome a very challenging problem long sought to be solved in the industry; that of wafer error reduction and elimination, especially in heavy volume wafer processing.

Therefore, Hoshina, as indicated above, only teaches an acute angle in the range of 40-80 degrees, otherwise, an angle greater than 80 degrees will result in adhesion which causes cracks or breakage when taking out the wafer 3 from the pocket. Thus, Appellants traverse the assertion that Hoshina teaches Appellants' invention.

For at least the reasons outlined above, Appellants respectfully submit that neither Honma nor Hoshina, alone or in combination, disclose, teach or suggest, including the projections have a beveled edge, such that an acute angle greater than 80 degrees occurs between

the lower surface and the beveled edge as recited in independent claim 1, and similarly independent claims 7 and 15, of Appellants' invention. Therefore, the Board is respectfully requested to reconsider and withdraw the rejections to claims 1, 7, and 15.

(b) The Rejection Based on Zhao in view of Hoshina

Regarding independent claims 1, 7, and 15, first, the references, separately, or in combination, fail to disclose, teach or suggest a reason or motivation for being combined. Second, even assuming that the references would have been combined, Zhao does not teach or suggest the features of independent claim 1, and similarly independent claims 7 and 15, including the projections have a beveled edge, such that an acute angle greater than 80 degrees occurs between the lower surface and the beveled edge.

Indeed, the Office Action admits that Zhao "do[es] not disclose [a] plurality of beveled edge projections extending radially inward from the inner edge," let alone, the above indicated feature. Accordingly, Zhao is deficient in not disclosing Appellants' claimed invention. (See Office Action, Page 3, Section 3). Hoshina is also deficient for the reasons indicated above (in section VIII B.1.(a) above).

Hoshina, as indicated above, only teaches an acute angle in the range of 40-80 degrees, otherwise, an angle greater than 80 degrees will result in adhesion which causes cracks or breakage when taking out the wafer 3 from the pocket. Thus, Appellants traverse the assertion that Hoshina teaches Appellants' invention.

For at least the reasons provided above (in section VIII B.1.(a) above), Appellants respectfully submit that neither Zhao nor Hoshina, alone or in combination, disclose, teach or suggest, including the projections have a beveled edge, such that an acute angle greater than 80

degrees occurs between the lower surface and the beveled edge as recited in independent claim 1, and similarly independent claims 7 and 15, of Appellants' invention.

In view of the foregoing, the Appellants respectfully submit that the cited prior art references do not teach or suggest the features defined by independent claims 1, 7, and 15 and as such, claims 1, 7, and 15 are patentable over Honma in combination with Hoshina or Zhao in combination with Hoshina. Therefore, the Board is respectfully requested to reconsider and withdraw the rejections to claims 1, 7, and 15.

2. Dependent claims 2-6, 9-14, and 17-18

Appellants respectfully traverse the rejections in the Office Action of dependent claims 2-6, 9-14, and 17-18 based on the following discussion.

(a) Dependent claims 2 and 10

Dependent claims 2 and 10 generally provide, "wherein said apparatus comprises a susceptor for holding said substrate." While Honma, Hoshina, and Zhao teach susceptors holding wafers, they do not do so in the manner provided by Appellants' susceptor, which allows for improved film uniformity on the semiconductor wafer undergoing processing. In fact, the susceptors disclosed in each of Honma, Hoshina, and Zhao do not guarantee good film uniformity for single wafer tools as does the Appellants' susceptor. Therefore, the Board is respectfully requested to reconsider and withdraw the rejections to claims 2 and 10.

(b) Dependent claims 3, 11, and 18

Dependent claims 3, 11, and 18 generally provide, "wherein said projections have a "C" shape." Clearly neither Honma nor Zhao teach "C" shaped projections. Moreover, the

protrusions 17 in FIG. 5A of Hoshina are configured on the lower half of the pocket 13 and are symmetrically placed in relation to the vertical line running through the centor of the pocket 13 (Col. 1, lines 55-58 of Hoshina). The configuration of the Appellants' projections are not so limited. Additionally, there is no description in Hoshina as to the actual shape of the protrusions 17. Rather, it appears that the Office Action is assuming that FIG. 5A discloses "C" shaped protrusions. However, without substantiation in the specification of Hoshina, this conclusion may not necessarily be correct. Therefore, the Board is respectfully requested to reconsider and withdraw the rejections to claims 3, 11, and 18.

(c) Dependent claims 4 and 12

Dependent claims 4 and 12 generally provide, "wherein said projections maintain a gap between a sidewall of said substrate and said inner edge." With regard to this feature of the Appellants' invention, the Office Action argues inherency; that is, that Hoshina inherently teaches this feature. However, case law establishes that an obviousness rejection is improper if specific claimed features are not taught in the prior art, but are instead rejected on inherency. See generally, In re Spormann, 363 F.2d 444, 448, 150 USPQ 449, 452 (C.C.P.A. 1966). Thus, the obviousness rejections based on inherency for claims 4 and 12 are improper. Therefore, the Board is respectfully requested to reconsider and withdraw the rejections to claims 4 and 12.

(d) Dependent claims 5, 13, and 17

Dependent claims 5, 13, and 17 generally provide, "wherein said acute angle comprises an angle not greater than 85 degrees." Clearly, the acute angle referred to in claims 5, 13, and 17 refer to the the acute angle greater than 80 degrees provided in independent claims 1, 7, and 15.

Thus, dependent claims 5, 13, and 17 essentially provide the range of the angle (i.e., greater than 80 degrees but less than 85 degrees). Thus, as previously indicated, neither Honma, Hoshina, nor Zhao teach an angle greater than 80 degrees. Hence, it follows that neither Honma, Hoshina, nor Zhao can teach an angle greater than 80 degrees but less than 85 degrees, as implicitly provided in dependent claims 5, 13, and 17. Therefore, the Board is respectfully requested to reconsider and withdraw the rejections to claims 5, 13, and 17.

(e) Dependent claims 6 and 14

Dependent claims 6 and 14 generally provide, "wherein said projections prevent said substrate from moving within said pocket." With regard to this feature of the Appellants' invention, the Office Action argues inherency; that is, that Hoshina inherently teaches this feature. However, case law establishes that an obviousness rejection is improper if specific claimed features are not taught in the prior art, but are instead rejected on inherency. See generally, In re Spormann, 363 F.2d 444, 448, 150 USPQ 449, 452 (C.C.P.A. 1966). Thus, the obviousness rejections based on inherency for claims 6 and 14 are improper. Therefore, the Board is respectfully requested to reconsider and withdraw the rejections to claims 6 and 14.

(f) Dependent claim 9

Dependent claim 9 generally provides, "wherein said projections reduce an area of contact between said inner edge and said substrate." The Office Action tends to suggests that Appellants' projections will increase the contact area rather than reducing it (see page 4 of Office Action). This suggests a fundamental lack of understanding of the Appellants' invention, and the geometric configurations of Appellants' invention. Appellants' projections 115 prevent the

substrate 120 from contacting the remaining portions of the inner wall 110 of the apparatus 100. Therefore, the projections 115 substantially reduce the area of contact between the side wall of the substrate 120 and the inner wall 110. Reducing this area of contact decreases the amount of heat transfer from the inner wall 110 and the side wall of the substrate 120. By decreasing the amount of heat transfer between inner wall 110 and the side wall of the substrate 120, the likelihood of the substrate 120 melting or sticking to the inner wall 110 is substantially reduced or eliminated thereby preventing wafer out of pocket errors. Additionally, the likelihood of a thermal stress developing across the substrate 120 due to the edge of the substrate 120 becoming hotter than the center of the substrate 120 is also substantially reduced or eliminated thereby improving film uniformity. Similarly, the likelihood of a thermal stress developing across the substrate 120 and causing warpage of the substrate 120 is also substantially reduced or eliminated thereby improving film uniformity and preventing wafer out of pocket errors. Thus, the Appellants' projections 115 clearly reduce the area of contact between the inner edge of the pocket and the substrate. Therefore, the Board is respectfully requested to reconsider and withdraw the rejection to claim 9.

D. CONCLUSION

In conclusion, the prior art references of record, either alone or in combination with one another, fail to teach essential elements of the Appellants' claimed invention. In many instances, there appears to be an unnecessarily broad interpretation of the prior art references as indicated in the Office Action. As indicated above, regardless of how each of the prior art references are interpreted they still fail to teach the Appellants' claimed invention as the prior art references either teach away from the Appellants' claimed invention, are contrary to the Appellants'

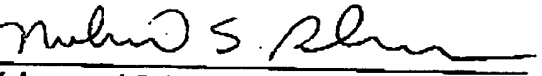
claimed invention, or all together are bereft of any teaching whatsoever of the elements provided in the Appellants' claimed invention.

In fact, each prior art reference cited by the Examiner is complete and functional in itself, so there is simply no motivation to use parts from or add or substitute parts to any reference to try and teach, but failing nonetheless, the claimed invention. Moreover, because the references take mutually exclusive paths and reach different solutions to a similar problem, they essentially teach away from each other, and thus it would not be logical for one of ordinary skill in the art to combine them. However, even if the references were legally combinable, as indicated above, the references would not teach the claimed invention because several claimed features are lacking in the prior art references. Furthermore, the several rejections based on Official Notice are demonstrated to be improper because the Examiner has failed to provide documented evidence in support of the precepts taken in Official Notice as previously requested by the Appellants.

In view of the foregoing, Appellants submit that claims 1-7, 9-15, and 17-18, all the claims presently pending in the application, are patently distinct from the prior art of record and are in condition for allowance. The Board is respectfully requested to cancel all of the rejections to the claims and to pass the application to issue. Please charge any deficiencies and credit any overpayments to Attorney's Deposit Account Number 09-0456.

Respectfully submitted,

Dated: November 7, 2006



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VIII. CLAIMS APPENDIX

Claim 1: An apparatus for holding a substrate, said apparatus comprising:

a pocket adapted to hold said substrate, wherein said pocket comprises an inner edge and a lower surface;

a plurality of projections extending radially inward from said inner edge;

an opening in said lower surface; and

a pin disposed in said opening, said pin being configured for lifting said substrate from said pocket;

wherein said projections have a beveled edge, such that an acute angle greater than 80 degrees occurs between said lower surface and said beveled edge, and

wherein said projections reduce an area of contact between said inner edge and said substrate.

Claim 2: The apparatus of claim 1, wherein said apparatus comprises a susceptor for holding said substrate.

Claim 3: The apparatus of claim 1, wherein said projections have a "C" shape.

Claim 4: The apparatus of claim 1, wherein said projections maintain a gap between a sidewall of said substrate and said inner edge.

Claim 5: The apparatus of claim 1, wherein said acute angle comprises an angle not greater than 85 degrees.

Claim 6: The apparatus of claim 1, wherein said projections prevent said substrate from moving within said pocket.

Claim 7: An apparatus for holding a substrate, said apparatus comprising:

a pocket adapted to hold said substrate, wherein said pocket comprises an inner edge and a lower surface;

a plurality of projections extending radially inward from said inner edge; and

an opening in said lower surface;

wherein said projections have a beveled edge, and

wherein an acute angle greater than 80 degrees occurs between said lower surface and said beveled edge.

Claim 8: (Canceled)

Claim 9: The apparatus in claim 7, wherein said projections reduce an area of contact between said inner edge and said substrate.

Claim 10: The apparatus of claim 7, wherein said apparatus comprises a susceptor for holding said substrate.

Claim 11: The apparatus of claim 7, wherein said projections have a "C" shape.

Claim 12: The apparatus of claim 7, wherein said projections maintain a gap between a sidewall of said substrate and said inner edge.

Claim 13: The apparatus of claim 7, wherein said acute angle comprises an angle not greater than 85 degrees.

Claim 14: The apparatus of claim 7, wherein said projections prevent said substrate from moving within said pocket.

Claim 15: A susceptor for holding a wafer, said susceptor comprising:

a pocket adapted to hold said wafer, wherein said pocket comprises an inner edge and a lower surface;

a plurality of projections extending radially inward from said inner edge; and

a device positioned below said pocket, said device being configured for lifting said wafer from said pocket;

wherein said projections have a beveled edge, and

wherein an acute angle greater than 80 degrees occurs between said lower surface and said beveled edge.

Claim 16: (Canceled)

Claim 17: The susceptor of claim 16, wherein said acute angle is not greater than 85 degrees.

Claim 18: The susceptor of claim 17, wherein said projections have a "C" shape.

Claim 19: (Canceled)

IX. EVIDENCE APPENDIX

There is no other evidence known to Appellants, Appellants' legal representative or Assignee which would directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

X. RELATED PROCEEDINGS APPENDIX

There are no other related proceedings known to Appellants, Appellants' legal representative or Assignee which would directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

SPECIFICATION

Electronic Version 1.2.8
Stylesheet Version 1.0

SUSCEPTOR POCKET WITH BEVELED PROJECTION SIDEWALL

Background of the Invention

[0001] Field of the Invention

[0002] The present invention generally relates to semiconductor wafer processing and, in particular, to an apparatus for supporting semiconductor wafers during processing and for providing film uniformity improvements on wafers.

[0003] Description of the Related Art

[0004] Conventional wafer support mechanisms, such as susceptors, do not guarantee good film uniformity for single wafer tools. Often, these conventional susceptors yield films with poor and uneven uniformities, and with WOOPS (Wafer Out Of Pocket) errors, which results in subsequent reworking procedures. Moreover, conventional tools attempt to level the susceptor to prevent any sliding of the wafer. In fact, conventional tools use a leveling kit to set up the susceptor. However, the level of the susceptor shifts with time, thereby creating uniformity problems.

[0005] In the semiconductor wafer and substrate processing fields, various types of processing equipment are utilized which provide for automated handling of wafers in a vacuum environment. One of the more important concerns in the handling and processing of such wafer substrates is the need to minimize particle generation that could contaminate the wafers, subsequently damaging the devices being formed thereon. In an effort to ameliorate this, most semiconductor device fabrication is conducted within a "clean room" environment where extreme measures are taken to minimize the presence of particulate matter.

[0006] At a process station, it may be necessary to hold the wafer firmly against a

support surface with a clamp during processing, for example, to maintain the position of the wafer relative to the processing equipment or to maintain good thermal contact to a heat transfer element. One conventional technique for maintaining the temperature of a wafer undergoing processing in a vacuum environment is to introduce a conductive gas in a narrow space at the backside of the wafer, thereby thermally coupling the wafer to a temperature control element. When using a backside gas, which is introduced at a pressure higher than the ambient pressure of the processing chamber, clamping means are required to ensure that the backside gas does not move the wafer off of the support surface.

[0007] In most cluster tool systems, and many other types of semiconductor processing systems, the wafers are loaded onto and removed from the process platform in a horizontal orientation. This allows gravity to be used to hold the wafer in place on the surface of the platform while the wafer is clamped and un-clamped. Therefore, un-clamping normally involves simply translating the clamp mechanism in an upward direction, and relying on gravity to cause separation of the wafer and the clamp.

[0008] Unfortunately, the conventional methods used in a process chamber may cause the clamp to adhere to a wafer after completion of processing of the wafer at the process station, thus preventing the wafer from being picked up by the transport mechanism such as an automated clasp. For example, this may occur when a metal layer is deposited over a wafer which causes the wafer to stick to the clamp. Another example is when the top layer of a wafer melts at an elevated temperature, causing the top layer to adhere to the clamp.

[0009] When a semiconductor wafer sticks to a clamp, the processing system typically must be shut down to free the stuck wafer, a procedure that normally involves manual intervention at atmospheric pressure. After the process chamber is vented to atmosphere to permit manual wafer removal, it can take several hours before the chamber can be placed back in service due to the need to pump down the chamber and allow out-gassing of contaminants (e.g., water vapor, etc.) that have become adsorbed to the chamber surfaces. Thus, it can easily take several hours to recover from a stuck wafer.

[0010] Conventional systems have not adequately solved this problem. Moreover, the

conventional systems have not adequately provided a device which improves the film uniformity of the semiconductor wafer undergoing processing. As such, wafers are constantly being processed with defects, thereby resulting in time consuming and costly rework procedures. Therefore, there is a need for a new and improved semiconductor wafer processing apparatus, which greatly improves the film uniformity of the wafer during processing, and which can be installed easily.

Brief Summary of the Invention

[0011] In view of the foregoing and other problems, disadvantages, and drawbacks of the conventional semiconductor wafer processing mechanisms, the present invention has been devised, and it is an object of the present invention to provide an apparatus for holding a substrate during semiconductor processing, thereby resulting in improved film uniformity on the semiconductor wafer undergoing processing. It is another object of the present invention to provide an easy set-up of the susceptor level. Yet another object of the present invention is to provide for installation of a new apparatus with repeatable good uniformities without errors, and without requiring rework of the susceptor. Still, another object of the present invention is to provide good process results even with susceptor leveling shifts. Another object of the present invention is to provide a susceptor with small points of contact with the wafer. It is yet another object of the present invention to improve the angle of the contacts to the wafer.

[0012] In order to attain the objects suggested above, there is provided, according to one aspect of the invention, a process of releasably securing a semiconductor substrate in a processing apparatus. The apparatus comprises a plate having a pocket holding the substrate. A plurality of members extending radially inward from the inner edge of the pocket and have an inclined beveled edge that produces an acute angle between the lower surface and the beveled edge. The members reduce the area of contact between the inner edge of the pocket and the substrate. The plate could comprise a susceptor for a low pressure single wafer chemical vapor deposition (CVD) tool. Moreover, the members are positioned to provide a minimum of two points of contact between the substrate and the inner edge of the apparatus. The invention is especially useful because the substrate is used in an environment that produces substrate warpage,

such as thermal chemical vapor deposition (CVD), annealing, and a physical vapor deposition (PVD).

Brief Description of the Several Views of the Drawings

[0013] The foregoing and other objects, aspects and advantages will be better understood from the following detailed description of a preferred embodiment of the invention with reference to the drawings, in which:

[0014] Figure 1 is a top view schematic diagram of an apparatus for holding a substrate according to a first embodiment of the present invention;

[0015] Figure 2 is a cross-sectional schematic diagram of the apparatus shown in Figure 1 along line I-I; and

[0016] Figure 3 is a magnified schematic diagram of the portion 205 of the apparatus shown in Figure 2.

Detailed Description of the Invention

[0017] As mentioned, there is a need for a new and improved apparatus for holding a substrate during semiconductor processing thereby resulting in improved film uniformity on the semiconductor wafer undergoing processing. Current susceptors do not guarantee good film uniformity for single wafer tools. Referring now to the drawings, and more particularly to Figures 1-3, there are shown preferred embodiments of the structures according to the present invention.

[0018] More specifically, Figure 1 is a top view of an apparatus 100 for holding a substrate 120. For example, the apparatus could be a susceptor that holds a wafer and provides a conduction path for heating the wafer. The apparatus includes an outer wall 105 and an inner wall 110 that defines a pocket (trench, cutout, opening, etc.) 125 in which the wafer 120 is positioned. The inner wall 110 includes projections 115 that extend radially inward and that make contact with the substrate 120. Otherwise, the inner wall 110 is not beveled and is substantially perpendicular to the bottom of the pocket 125. The projections 115 are shown in Figure 1 as having a "C" or "U"-finger-like shape when viewed from the top; however, the projections could have a number of different shapes depending upon the specific application. In addition, three

projections 115 are shown in Figure 1; however, the number of projections can be unlimited, so long as there are at least two projections to prevent the substrate 120 from contacting the inner wall 110.

[0019] In other words, the projections 115 prevent the substrate 120 from contacting the remaining portions of the inner wall 110 of the apparatus 100. Therefore, the projections 115 substantially reduce the area of contact between the side wall of the substrate 120 and the inner wall 110. Reducing this area of contact decreases the amount of heat transfer from the inner wall 110 and the side wall of the substrate 120. By decreasing the amount of heat transfer between inner wall 110 and the side wall of the substrate 120, the likelihood of the substrate 120 melting or sticking to the inner wall 110 is substantially reduced or eliminated thereby preventing wafer out of pocket errors. Additionally, the likelihood of a thermal stress developing across the substrate 120 due to the edge of the substrate 120 becoming hotter than the center of the substrate 120 is also substantially reduced or eliminated thereby improving film uniformity. Similarly, the likelihood of a thermal stress developing across the substrate 120 and causing warpage of the substrate 120 is also substantially reduced or eliminated thereby improving film uniformity and preventing wafer out of pocket errors.

[0020] Figure 2 illustrates a cross-section of the apparatus 100 shown in Figure 1 along line I–I. In addition to the outer wall 105, inner wall 110, projections 115, and substrate 120; Figure 2 also illustrates a device 215 (pin) within an opening 210 that is used to lift the substrate 120 from the pocket 125 when necessary. Figure 2 also illustrates the gap between the inner wall 110 and the side wall of the substrate 120 that is created by the projections 115.

[0021] Figure 2 also illustrates angles 200, 201 that formed by the beveled side wall of the projection 115. The region 205 is shown in magnified form in Figure 3. The angle 200 is generally between 5 and 10 degrees, although the invention is not limited to this specific range of angles, but is applicable to all ranges of appropriate angles, depending upon the specific application being addressed. Therefore, the angle 201 comprises an acute angle. Thus, the angle between the bottom of the pocket 125 and the linear inclined surface of the projection 115 is less than 90 degrees (e.g., 80–85

degrees). The beveled side wall of the projection 115 further reduces the contact area between the projection 115 and the substrate 120, thereby further reducing the possibility that the substrate 120 will stick within the pocket 125 of the apparatus 100.

[0022] The apparatus 100 is made of a substantially rigid material such as graphite and the projection 115 is made of a thermally conductive material such as silicon carbide; however, the projection 115 will experience some deformity when contacting the substrate 120. This small amount of deformity helps maintain the substrate 120 securely within the pocket 125. In other words, the upper portion of the beveled edge of the projection 115 presses firmly against the substrate 120 to hold the substrate 120 in position. Therefore, the substrate 120 will not move within the pocket. This increases processing precision and yield because the substrate 120 remains in position during processing which results in improved film uniformity and reduced foreign material.

[0023] There are several benefits of the present invention. First, the present invention provides an apparatus for holding a substrate during semiconductor processing thereby resulting in improved film uniformity on the substrate undergoing processing for improving yield. The present invention provides for installation of a new apparatus into a process system with a guarantee of repeatable good uniformities and without requiring rework of the susceptor thereby improving the process system availability and reducing costs. Another benefit of the present invention is that it provides good process results even with shifts in the level of the susceptor since the substrate is kept securely within the pocket. Additionally, the present invention provides small points of contact with the wafer to minimize the amount of heat transfer from the apparatus to the substrate thereby minimizing thermal stress on the substrate. Also, the present invention improves the angle of the contacts to prevent wafer out of pocket errors which increases process system availability.

[0024] While the invention has been described in terms of preferred embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the appended claims.

What is Claimed is:

[c1] 1. An apparatus for holding a substrate, said apparatus comprising:
a pocket adapted to hold said substrate, wherein said pocket has an inner edge and a lower surface; and
a plurality of projections extending radially inward from said inner edge, wherein said projections have a beveled edge, such that an acute angle occurs between said lower surface and said beveled edge, and wherein said projections reduce an area of contact between said inner edge and said substrate.

[c2] 2. The apparatus of claim 1, wherein said apparatus comprises a susceptor for a substrate.

[c3] 3. The apparatus of claim 1, wherein said projections have a "C" shape.

[c4] 4. The apparatus of claim 1, wherein said projections maintain a gap between a sidewall of said substrate and said inner edge.

[c5] 5. The apparatus of claim 1, wherein said acute angle comprises an angle between 80 and 85 degrees.

[c6] 6. The apparatus of claim 1, wherein said projections prevent said substrate from moving within said pocket.

[c7] 7. An apparatus for holding a substrate, said apparatus comprising:
a pocket adapted to hold said substrate, wherein said pocket has an inner edge; and
a plurality of projections extending radially inward from said inner edge, wherein said projections have a beveled edge.

[c8] 8. The apparatus in claim 7, wherein an acute angle occurs between a lower surface of said pocket and said beveled edge.

[c9] 9. The apparatus in claim 7, wherein said projections reduce an area of contact between said inner edge and said substrate.

[c10] 10. The apparatus of claim 7, wherein said apparatus comprises a susceptor for

a substrate.

[c11] 11. The apparatus of claim 7, wherein said projections have a "C" shape.

[c12] 12. The apparatus of claim 7, wherein said projections maintain a gap between a sidewall of said substrate and said inner edge.

[c13] 13. The apparatus of claim 8, wherein said acute angle comprises an angle between 80 and 85 degrees.

[c14] 14. The apparatus of claim 7, wherein said projections prevent said substrate from moving within said pocket.

[c15] 15. A susceptor for holding a wafer, said susceptor comprising:

a pocket adapted to hold said wafer, wherein said pocket has an inner edge; and

a plurality of projections extending radially inward from said inner edge, wherein said projections have a beveled edge.

[c16] 16. The susceptor in claim 15, wherein an acute angle occurs between a lower surface of said pocket and said beveled edge.

[c17] 17. The susceptor of claim 16, wherein said acute angle is between 80 and 85 degrees.

[c18] 18. The susceptor of claim 17, wherein said projections have a "C" shape.

SUSCEPTOR POCKET WITH BEVELED PROJECTION SIDEWALL

Abstract of the Disclosure

An apparatus for holding a semiconductor substrate comprises a plate having a pocket which holds the substrate, wherein the pocket comprises a lower surface and an inner edge. The inner edge comprises a plurality of members extending radially inward to reduce the area of contact between the inner edge and the substrate. The beveled edge is inclined so that there is an acute angle between the lower surface of the pocket and the beveled edge.

Figures

Johnson et al.
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Sheet 1 of 2

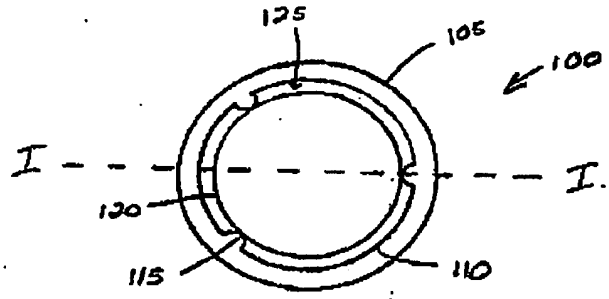

Figure 1

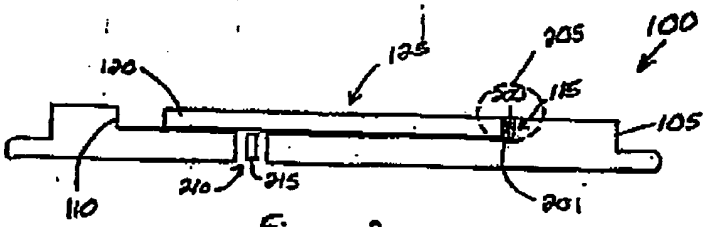

Figure 2

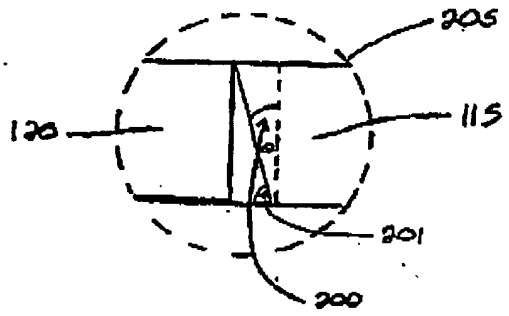

Figure 3